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CHNICAL QUARTERLY
FICIAL PUBLICATION
THE PHOTOGRAPHIC
CIETY OF AMERICA

Editorial Correspondence

Gentlemen:

One of our readers has called attention to recent advertisements for Contaflex cameras, Model II, which mention the "Built-in ASA photoelectric exposure meter." Some skepticism was expressed that the meter performance really comes up to the requirements specified in American Standard General-Purpose Photographic Exposure Meters (Photoelectric type) Z38.2.6—1948.

Perhaps others have had the same reaction, in which case you might wish to give us a letter dealing with the subject that we can publish for the information and education of our professional readership. I am sure that the Zeiss organization has good, sound reasons for making such a claim and it seems appropriate to bring those reasons to the attention of the technical people concerned with photography in this country.

PAUL ARNOLD

Editor, P.S.&T.

Dear Sir:

In reply to your letter we take pleasure in informing you that the Zeiss-Ikon factory in Western Germany has repeatedly assured us that their exposure meters conform to the ASA norm Z38.2.6—1948. The exposure meters built for distribution in the United States are calibrated in DIN and ASA values.

H. THORLICHEN

Carl Zeiss, Inc.
New York, N. Y.

To the Members of
The Technical Division:

In considering proposals and ballots contained in the special issue of the Technical Division News Letter being mailed by headquarters, it should be understood that, in accordance with the Society's Constitution and By-Laws, any action taken will be that of individual members.

The Technical Division and the official Society publication, PHOTOGRAPHIC SCIENCE AND TECHNIQUE, both in name and activities, are part and parcel of PSA. They will be continued regardless of the decision of the individual members of the Technical Division.

December 29, 1955 M. M. PHOLEY, President

PLASTIC PIPE AND FITTINGS

Bulletins available from Alpha Plastics, Inc. of 15 Northfield Road, West Orange, N. J. give detailed reference information for the proper selection of their line of unplasticized, rigid polyvinyl chloride pipe and fittings. Two types are described, Alpha 101 and Alpha 102. The first produces an extremely hard, tough and rigid plastic product with outstanding resistance to a broad group of industrial chemicals. The second type is modified to provide notched impact resistance unequalled by any other thermoplastic material, according to the literature, which is available on request.

ELECTRONIC FLASHTUBE DATA

Kemlite Laboratories of 1819 West Grand Avenue, Chicago 22, Illinois have issued a bulletin giving specification data on ionizing, electronic flashtubes for photographic, stroboscopic, ultraviolet and infrared applications. Both flashtubes and flashtube-reflector combinations for photography, used with either 240 or 300 volt power sources, are included.

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PHOTOGRAPHIC SCIENCE AND TECHNIQUE is dedicated to the publication of scientific and technical papers dealing with the theory and practice of photography. Its aim is to encourage the publication of authoritative articles describing original research, techniques, and the engineering aspects of new equipment in all fields of photography. It is intended to interest and inform the advanced amateurs, the professionals, the technologists, and the scientists who study or apply photographic processes.

Established in 1950, Photographic Science and Technique is prepared under the editorial management and control of the Technical Division of the Society. The first four volumes were issued as Section B of the PSA Journal and numbered 16B to 19B inclusively. As a separate publication, Series II, Volume 1, Number 1 started in the first quarter of 1954.

Members of the Photographic Society are entitled to receive both the monthly PSA Journal and this quarterly technical publication. Non-member subscriptions are available only to libraries, schools, and Government units at $5.00 a year ($9.00 for two years) for both publications together. Separate subscriptions are not available. Single copies, including back issues when available, at Society Headquarters in Philadelphia, $1.00 a copy. No extra charge for overseas mailing.

Address manuscripts and communications to the Editor. The Associate Editors are available for advice and assistance in the preparation of manuscripts. Unacceptable manuscripts will be returned if requested. Authors will be sent galley proofs for correction. Reprints may be ordered by the authors prior to publication.

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PHOTOGRAPHY AS THE TECHNICAL EDITOR SEES IT

Christian K. Arnold*

A TECHNICAL REPORT is a complicated form of communication. Perhaps no other one actively combines so many different elements. These elements include words (along with numbers and symbols), mathematics, tables, charts, diagrams, color, typography, arrangement (or layout)—and photographs. It is the editor's job to blend these elements into a homogeneous whole, the prime virtues of which are accuracy, clarity, unity, conciseness, and interest, perhaps in that order.

There is no fixed recipe for this blending, since each reporting job is unique. Nor are all the elements used in every report. However, when a needed element is missing, there is no adequate way to compensate for its absence. The editor has a large measure of control over most of the elements with which he works. He can rewrite the text, construct or reconstruct the tables, and control color and layout within the framework of the available facilities. He is, however, likely to run into trouble with photographs, simply because the equipment he needs to show by means of a picture was probably torn down, modified, or shipped elsewhere long before the report was written. Even if the equipment is still around, there is seldom time to dust it off, reassemble it, make an exposure, develop the negative, and print the picture. Editing and printing the report are the last step of a project that has been running perhaps for years, and the scientist can rarely understand why submission to the editorial staff of the data he has collected is not synonymous with distribution. Consequently, the editorial process can seldom tolerate delays—not, at any rate, if the editor wants to keep his job.

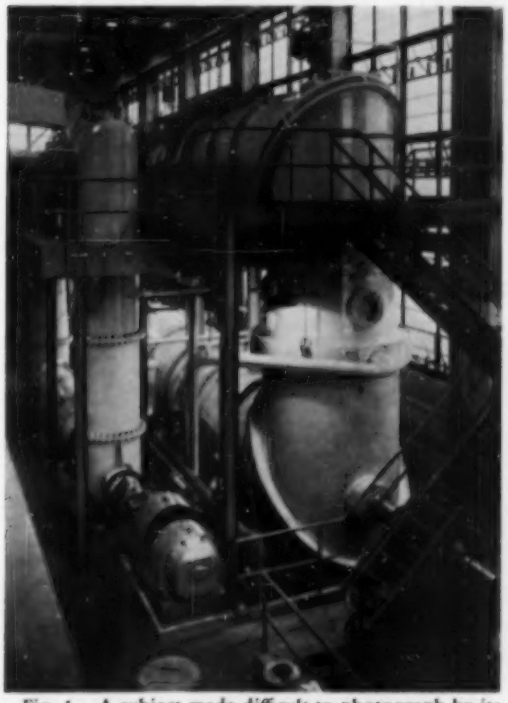

Fig. 1. A subject made difficult to photograph by its size, complexity, and the limited number of available camera locations. To the careful observer, the stairs give a good indication of size.

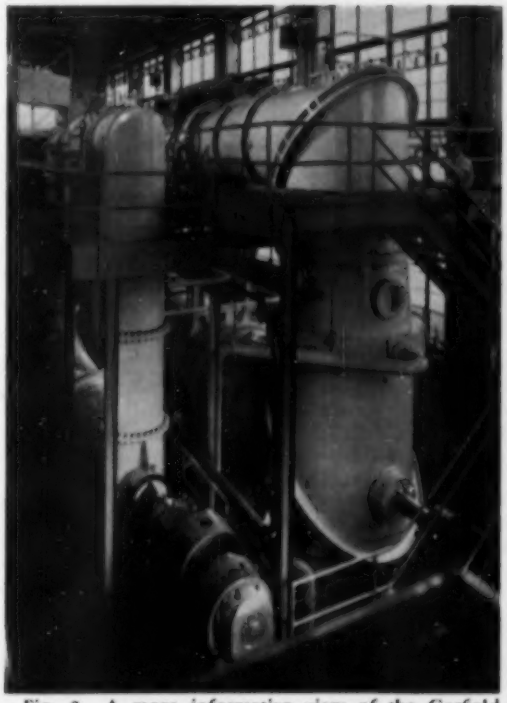

Fig. 2. A more informative view of the Garfield Thomas Water Tunnel of the Ordnance Research Laboratory. The addition of the man on the stairs gives an immediately apparent indication of the size of the installation.

The editor, then, must rely completely on the photographer for the pictures he so desperately needs. How can the photographer make certain that adequate pictures are available when they are needed? The advice of the technical editor can be summed up in one sentence: take lots of pictures, make sure they satisfy the requirements of sound exposition, and file them so they can be found.

Of course, the editor expects top mechanical quality, just as he expects perfection in the mechanical details

* Ordnance Research Laboratory, The Pennsylvania State University, University Park, Pennsylvania. Received 25 November, 1955.

Fig. 3. Without the dimension block, this model might be mistaken for a full-sized torpedo. The spotlight was used for emphasis. However, such lighting makes it almost impossible to crop the picture and produces shadows that might be undesirable in some applications.

of grammar, spelling, punctuation, and the like. The editor is seldom disappointed in this expectation. Almost without exception, photographers are extremely meticulous with their lighting, exposure times, developing procedures, and other mechanical details. The prints they deliver to the editorial office are uniformly excellent in "photographic" quality. The chief difficulties are that not enough pictures are taken, those that are taken often fail to communicate, and all too often they cannot be found when they are needed.

The Role of the Technical Photographer

To satisfy the first of these requirements, the photographer in a research and development organization must want to take pictures, just as the editor must want to write and publish, and he must know what's going on in the organization. He cannot meet this requirement by waiting in his studio for job orders to come in. They won't. At least, not in sufficient numbers. An engineer is, understandably, almost always so engrossed in the work itself that he is apt to forget about ordering a picture of his test setup. Of course, after the experiment is wrapped up in a neat development, a photograph will be ordered. And the editor will have to resort to at least some of those much-maligned 10,000 words or to a dull, flat schematic drawing to describe the equipment used in obtaining the data that made the development possible. If, however, the photographer had suggested taking a picture of the setup earlier, the engineer would have been glad to cooperate.

It might be argued that this sort of thing is going beyond the call of duty. Perhaps it is. But the engineer is going beyond the call of duty when he returns to the laboratory in the evening to conduct some collateral research that couldn't be funded under the contract, and the editor is going beyond the call of duty when he suggests the material would make a good article and helps the engineer to write it. The important thing is that the photographer is the only member of the research team whose primary responsibility is the photographic documentation of the work of the team. Even more than technical excellence, it should be his pride that the work of the organization is recorded in pictures as completely as possible. His must be more than a passive service function; he must be a dynamic force in getting pictures taken.

To serve dynamically in this way, the photographer has to know what's going on. This does not mean he must be a scientist or an engineer, but it does mean he must be curious and alert. Almost everyone likes to talk about his own work, even the scientist. With the possible exception of the pay clerk and certain administrative officials, the photographer should probably be the most widely known and recognized person in the organization. One very successful technical photographer devised a special kit so that he could carry enough equipment with him to take pictures during fairly regular "social" tours through the laboratories.

If this makes the photographer in a research and development laboratory sound like a combination of press photographer, newspaperman, publicist, amateur scientist, and general snoop, I have no objection. The picture that is not taken today cannot be used in a report to be written next summer. And only the photographer has a primary interest in the taking of pictures. It is far better to err on the side of taking too many pictures than to end up with an incompletely documented project report.

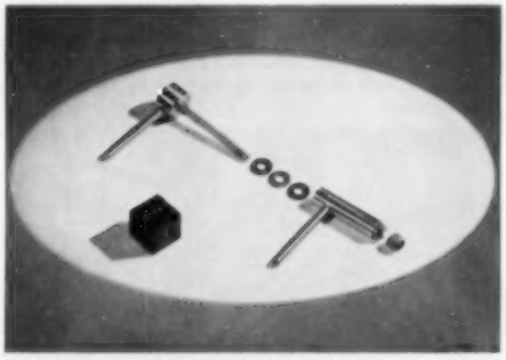

Fig. 4. Especial care must be taken to make exploded views clear and interesting. Here the dimension block does not give as good an indication of size as would a ruler placed along the length of the composition. Also, a complementing long line here would be better compositionally than is a square, black block.

Technical Pictures Must Communicate

The pictures the photographer takes must, above all else, communicate. Success in this requirement depends basically, I think, on an attitude or a point of view. The photographer must look on his pictures as graphic expositional paragraphs rather than as (1) works of art or (2) routine service assignments. He must shift his primary attention from exposure times, types of cameras, lenses, lighting, etc., to *what* he is photographing and *why* he photographs it. Mechanical excellence is important, but the skill to secure it should be so well implanted that the photographer can concentrate on the more difficult problem of exposition.

Again, to satisfy this requirement, the photographer must be a dynamic force in the organization. When a scientist brings a piece of equipment to the studio to have a picture taken, he will seldom tell the photographer anything about it, not, at least, unless he is asked. The regular record-type picture will probably satisfy him, since the communications job here is practically nil. The scientist already knows all about the equipment. But the readers of the report in which the picture will appear know nothing about it. The photographer can perform a real service for the scientist by finding out all about the apparatus—what it is supposed to do, what is important about it, how it differs from others of its type—and then doing his best to show these things in photographs. The more of these things shown in the pictures, the better the final report will be. Don't just shoot; shoot to say something, even if you must listen to an hour's lecture to find out what to say. The most beautiful combination possible of a given group of words is absolutely useless unless the words are arranged in a meaningful sequence.

Indications of Scale Are Needed

There are some points in this area upon which specific suggestions can be made. Accuracy, for instance, dictates that some indication of size be included in almost every picture. The editor can tell the reader what the size is, but such an indication is not nearly as significant as one given right in the picture. The size of the subject, the degree of accuracy desired, and the intended use govern the selection of the reference. For small objects, a hand, wrist watch, pencil, cigarette—any number of small familiar objects—can be used for a dramatic indication, and the photographer should select the item carefully to make the proper associations and connotations with the object photographed. For greater accuracy, rules and blocks on which dimensions are clearly marked are indispensable. It is often desirable for these scales to be transparent so that details of the object are not obscured. For larger objects, people can be used, but only with caution. An awkward or unnaturally stiff pose of a person can make a laughing matter of the most serious research project. The editor, like the playwright, cannot risk a snicker in the middle of a serious production. And, Please, no Cheesecake!

Fig. 5. Photographs employing people can be made in the shops. The poses are not natural working positions, but they look natural and help to make a pleasing composition. A canvas curtain or screen could have eliminated some of the background, although it is not particularly disturbing here. The workbench under the machinery could have been cleaned up some.

Accuracy (and common courtesy to the reader) also dictates that all dials, numbering, and lettering be made legible, if it is at all possible to do so. This requirement may be unimportant, or even detrimental, to the picture as a work of art; but the readers of a technical report are interested in facts, and those legends and numbers are facts, often very important ones. Related to this matter is the size of the picture. It should always be at least as large as it will be in reproduction. It is better if it is $1^1/_2$ times reproduction size. It is often helpful, also, for the photographer to take the trouble to preserve texture. Such preservation reduces the number of words needed and adds accuracy and clarity to your print. Special techniques have been devised for bringing out a wide variety of surface finishes, and the photographer should be adept at using these.

Selection for Emphasis

Clarity dictates that the picture contain no more than one idea. The paragraph that divides the reader's attention between two or more topics is a disservice to communication; so is the picture with multiple emphasis. As with tables, it is usually better to use two simple, clearly understandable pictures than a single confused one. A lack of emphasis, in photography as well as writing, is just as bad as multiple emphasis, simply because it gives the reader no help in interpreting the material and results in a dull report.

To achieve these virtues in technical photographs, the compositions will have to be deliberately arranged, just as the writer must deliberately arrange the material of his paragraph, not simply to include everything that is pertinent and exclude everything that is not, but also to make the best possible use of emphasis. Careful attention to the rules of composition is even more important in a technical photograph than it is in one intended solely for pictorial purposes.

Because the composition must be controlled so closely, it is probably best to photograph as many subjects as possible in the studio where the photographer can utilize all the principles of good table-top photography. Photograph against a non-textured, contrasting background. Excellent effects can be obtained under certain conditions with shadowless shots with no backgrounds. Especial attention should be given to exploded views to make certain that they are clear, not to the scientist, but to the photographer, as the reader's representative.

If the photograph must be made in the field or the laboratory, do everything possible to keep the pictures uncluttered. Remove "glitch" from the foreground, wheel unrelated or otherwise unnecessary equipment out of camera range, and simplify backgrounds insofar as possible. One photographer has added a gray canvas curtain to his "traveling bag." This canvas, which is draped over machinery or held by workmen to block out all sorts of jarring details, has proved invaluable. Others have used cardboard screens successfully, but they are harder to carry around.

Fig. 6. A technical photograph does not have to be dull. If printed forms must be shown, this method is more pleasing and tells more than a straight-on rendering of them.

Despite frequent exhortations to "add people" to pictures for interest, most technical editors, I believe, do not think this is a good practice generally. People who work around research laboratories are not particularly good actors, and an unfortunate pose can kill the best of pictures. Most scientists and engineers do not understand the necessity for altering their normal working positions, and these positions often do not fit into the over-all composition pleasingly or functionally.

Above all else, do not fall into the sloppy habit of counting on ground-glass art or cropping to clean up pictures. No amount of art work can make a good picture out of a bad print. Besides, art work is expensive and time consuming. A need for excessive cropping might easily result in a print so small that important details will be lost in the consequent enlarging.

Introduction of Labels

Some organizations go so far as to ask the photographer to place arrows, labels, and the like on the equipment to indicate flow lines and to identify components. This practice obviates the necessity for overlays and reduces the art work to almost nothing. However, if these signs are not professionally done and carefully placed, they detract considerably from what might otherwise have been a completely adequate picture. If enough care is taken to make satisfactory signs, little if any saving in either time or money is realized. If facilities are available, it is probably best to rely on art work rather than to use such signs.

A technical report must be accurate and clear; it should be concise and coherent; extra benefits accrue to the organization if it is also interesting. The same thing is true of the photographs that form an integral part of the report. Interest, of course, is a relative thing; that which interests me may bore you to death. Why? Well, subject matter, technical quality, and the degree of imagination and insight with which the subject is handled are certainly three of the more important elements that control interest.

To a certain extent, the photographer and the editor have a captive audience. At least, it can be safely assumed that the readers are initially interested in the subject matter, but this interest may be dissipated amazingly fast. The editor (and the organization) wants desperately not simply to hold this initial interest but also to increase it. Since this reader is primarily seeking information, accuracy and clarity in both prose and pictures are necessary to prevent him from throwing the report aside in disgust; mechanical excellence in handling the material is required for holding his interest; and the extra benefits derived from imaginative treatment may well increase it.

Perhaps some people could never become interested in a picture of a process or a piece of machinery, but it hardly follows that those who are interested in the equipment are incapable of responding to beauty. A machine must perform the job for which it was designed; sales will be larger, however, if it is also a beautiful piece of furniture. Pictures must be functional; they should also be artistic. Good composition is as pleasing and effective in a picture which appears in a technical report as it is in one hung in a gallery.

A final word: please, no gag shots. The reader of the technical report has a sense of humor, quite possibly a boisterous one. But burlesque can easily cause him to suspect the seriousness with which the work he is reading about was carried out.

Cataloging and Filing

Finally, file, catalog, and index the pictures so that they can be found. If the photographs taken today cannot be located six months, a year, or longer from now, the photographer is wasting his time and the organization's money. In fact, it should be possible to find the picture even if everyone concerned has forgotten that such a picture was taken or if the only person who ever knew anything about it has long since been pirated by a rival organization.

The operating procedure of the organization will largely determine the best system to use, but some things can be said generally. Keep a print file; a negative file is almost always inadequate. Dates, names, project numbers, and the like are far more important than exposure data and other details of the photographic process of the picture taking. Actually, such details as exposure data are really important only to you and other photographers. The easier it is to find a picture, the better the editor will like it. He needs them, but he cannot use them if they are lost in a negative file.

The greatest single fault with technical writing is that the engineer or scientist is likely to forget all about the reader and write only for himself. This simplifies the writing job but does not contribute to the effectiveness of the report. The same thing is true of the technical photographer. Although he keeps the object he is photographing in focus, he forgets that he must also keep the reader in focus. Perhaps it would help if he would remember that, in final analysis, it is the reader who is paying his salary.

Acknowledgment

The author wishes to acknowledge the encouragement and helpful suggestions given him by Mr. John W. McFarlane of the sales service division of the Eastman Kodak Company.

THE OPTICAL AND PHOTOGRAPHIC CHARACTERISTICS OF THE PHOTON MACHINE

R. A. Higonnet, L. Moyroud, and L. Rosenblum*

SUMMARY

The Photon machine is described as a type-composing machine which produces optical images on photographic materials from which mechanical printing plates can be made. A brief description is given of the photographic and optical principles involved and the electrical and mechanical provisions for producing desired type size, type style, line length, line spacing, automatic justification, and a variety of spacing designs.

A HIGH-SPEED type-composing machine, the Higonnet-Moyroud or the PHOTON, photo-composition equipment, produces in positive form, on film, printed matter which can immediately and easily be used for graphic arts reproduction. Subsequent reproduction may be by the photo-offset process, by the letterpress process via photoengraving, by the gravure or by any other of the processes known to the printing industry. The principal features of the Photon machine are simplicity of operation, high quality of the finished product, and extreme versatility.

The particular advantages of photocomposition over hot metal and other forms of setting type are speed, accuracy, versatility, light weight of the composed material and compatibility with other processes of printing. The speed, for example, is a maximum of eight characters per second. This is equivalent to 80 words per minute, or 14,000 printer's "ems" per hour. The PHOTON (Figure one) consists of an information input system, which is a standard typewriter unit and a group of push buttons, an electro-mechanical computer which performs all the necessary spacing computations (most of which have, heretofore, been done manually by the typesetter), and a photographic unit.

To set type on the PHOTON machine, the operator first pre-selects the type face style, type size, line length, spacing between lines, and copy arrangement by pushing the appropriate buttons on the consoles to the right and left of the typewriter. He then commences typing in the ordinary manner. As material is being composed, a "proof" of the copy appears on paper placed in the typewriter and thus allows the operator to check for errors. The machine contains correction mechanisms so that any errors detected after keyboarding, but before the line is put on film, may be corrected.

The automatic copy arrangements possible are: Normal Justification in which the margins are made flush left and flush right by modifying the space between words and sometimes between letters as well; Flush or "Quad" Left, uneven right margins as in typewritten copy; Flush or "Quad" Right, uneven left margins; Centered; "Leaders", part of each line flush left and part flush right with large and varying amounts between (the remaining space may either be blank or filled with a series of dots—as in telephone book listings); and Multiple Justification, for columnar work. In all these arrangements, the amount of unused space is computed and distributed in the line automatically. In the case of "leader dots" the number of dots is computed and inserted automatically.

For each of these conditions, signal lights and buzzers indicate to the operator when the amount of copy typed in has reached the minimum or approaches the maximum that can be contained in the length of line selected. Overset lines may readily be reduced to settable lines with proper word breaks. In addition, even when style and size of type is changed in the middle of the line, allowance is automatically made for justification or other selected arrangements. The details of the computing and mechanical systems are covered in other papers.[1]

The Optical System

The main components of the optical system are: a xenon-filled flash tube, a disc containing 1408 characters, a series of "size" lenses, a "writing" lens, and the photosensitive material (Figures two and three). The flash tube is of a special design, having a flash duration of 3 to 4 microseconds. Its electrical energy input is approximately $^1/_6$-watt second. The average light intensity during the flash is approximately 3,000,000 lumens.

Fig. 1. The Photon composing machine showing the keyboard and controls in front. The photographic unit is enclosed in the rear of the apparatus.

* Mr. Rosenblum is associated with Photon, Inc. of Cambridge, Massachusetts. Mr. Higonnet and Mr. Moyroud are with the Graphic Arts Research Foundation, Inc., also of Cambridge. Presented at the PSA National Convention in Boston, Massachusetts, 8 October, 1955. Received 4 November, 1955.

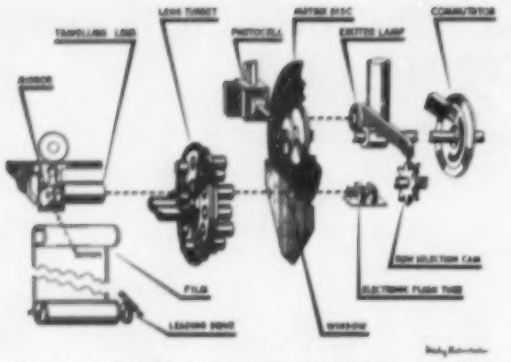

Fig. 2. Optical system of the Photon machine. Film of different widths may be accommodated depending on typesetting requirements.

A necessary incidental part of the optical system is the exciterlamp and photocell combination. This mechanism makes possible a precision of ±0.0002″ in the location of any character, despite the fact that the disc is revolving at a rate which produces a peripheral speed in the order of 190 inches per second (11 miles per hour). The timing of the flash is precise to within one microsecond.

The Matrix Disc contains 16 different styles of type, each style containing 88 characters. Each of the 1408 characters on the disc is approximately 0.060″ high (Figure four). Each type style is arranged in a semicircle in one of eight concentric circles. The characters are placed on the disc by photographic reproduction in a special camera (Figure five) where the original characters are 85 times those on the disc. The resolution of the images on the disc is in order of magnitude of 60 lines per millimeter, the limit being in the rounding of the corners of the serifs. This rounding effect is not at all detectable with the naked eye until the characters are magnified greater than sixteen times.

The sizes of the photocomposed characters are determined by the series of 12 "size" lenses contained in a rotatable turret. These lenses permit magnifications from $^{6}/_{6}$ disc size up to 5 times disc size, which correspond to printers' point sizes of 5 point (such as is used in dictionary footnotes) up to 36 point ($^{1}/_{2}$″). Simple achromats are used for the nine smaller sizes while inverted telephoto lens designs are used for the three larger sizes. Each inverted telephoto consists of a single element lens plus an achromat.

The writing lens is located in the collimated beam of the size lens selected and is on a moving mount so that it may travel over a range of 7 inches corresponding to the maximum length of line realizable on the machine. The light path is bent at 90° by a front surface mirror positioned at 45° to the axis of the writing lens and located between the writing lens and the image surface. This arrangement makes it possible to hold the film stationary while imaging each of the characters selected in turn on the "line of write" (one line of composed material). The travel of this writing lens and mirror is controlled by a mechanical escapement in accordance with computer signals governing the character width, the lens size, and the justification requirements. This lens is also an achromat.

The photosensitive material used is a high-contrast orthochromatic emulsion such as Kodak Contrast Process Ortho, Gevaert Dipos-Rapid and similar materials. It carries 35mm "positive" perforations along both sides for ease in transport and accuracy of location.

The film magazines hold 50-foot rolls in widths which may vary in size from $3^{3}/_{4}$ in. to $7^{3}/_{4}$ in. wide. The spacing between the lines is controlled by a film-feed mechanism in units of 1-point, (0.01383″), or may be adjusted to give $^{1}/_{2}$ point or 2 point units.

Any one of the 16 type styles of the disc may be brought into the photographing station by positioning the appropriate step of an 8-position cam and by selecting the appropriate half of the disc. The actual exposing operation is performed by flashing the xenon lamp as the correct character passes in front of it. The selection is controlled by a commutator system.

Exposure and Processing

Normal processing of the film is in D-11 developer for five minutes at 68 F. The standard exposure and this processing produces images with densities in the order of 2.8 density units. The accuracy of control required is that which is considered typical for the graphic arts industry. The time is generally held to ±15 seconds while the temperature is held to ±3 F.

While the material composed on the machine is normally in positive form, it is possible by additional processing to produce direct reversal images. The preferred technique, however, is to take the film in its positive form and then make negatives of the kind required for the regular graphic arts processes. In photoengraving for letterpress printing, a direct contact negative is made, while for the conventional offset process a negative is made with the emulsion on the opposite side. (This may be achieved either by photographic copying or by making the image on stripping film.) The Photon film in its original form has exactly the correct characteristics for the "dry offset" process, while the positive film as used in the gravure process must be made from the

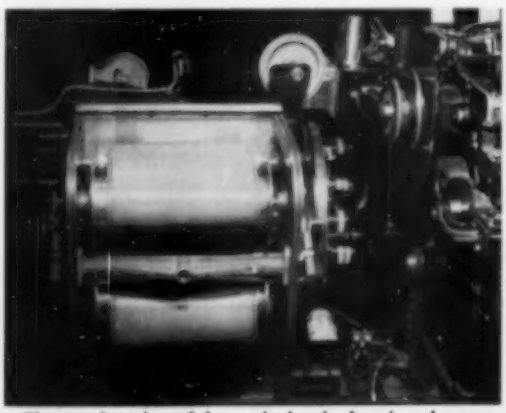

Fig. 3. Interior of the optical unit showing the components in approximately the same positions as they occupy in the schematic diagram in Fig. 2.

"other side" negative such as is made for conventional offset.

The matrix disc containing the 1408 letters of the 16 styles of type is made from an 8 in. glass plate $^1/_8$" thick coated with standard Kodalith emulsion. The characters are mounted in a special apparatus (Figure five) that consists of a master panel in which are placed 8 master drawings, each approximately 5" high (512 point size). These characters are located on the master board to a precision of ±0.016" which permits a precision at the disc of ±0.0002". The master board is illuminated with a series of 100-watt incandescent lamps so that the exposure of the disc is approximately 6 seconds at f/5.6. After the first exposure of 8 characters is made, the disc is indexed 2° and a second exposure is made of 8 more characters. In this way, the 1408 characters on the disc (and the two blank regions) are exposed in 180 separate steps.

In addition to the general advantages listed above, there are special versatility features incorporated in the Higonnet-Moyroud machine. For example, large initial capital letters with inset text letters ("fitted initials") such as are used to start new chapters or new paragraphs in books and fine printed work, may be made directly from the keyboard without hand work. These initials may be composed either aligned on the baseline as is done on the older forms of hand-set type, or aligned with the top of the character as has been more common

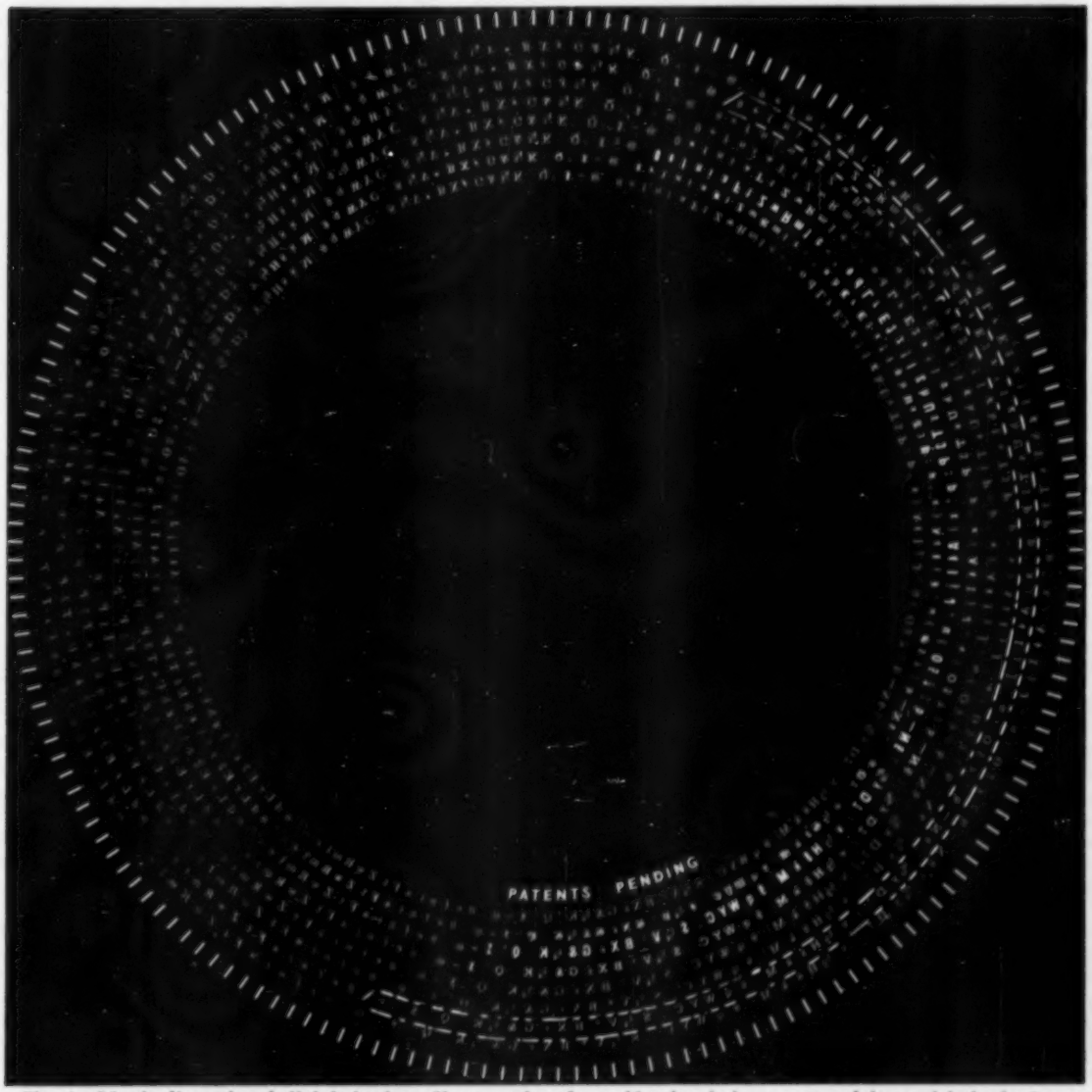

Fig. 4. Matrix disc reduced slightly in size. Sixteen styles of type (6 point size) are arranged in semicircles in 8 concentric rows. The dotted line encompasses the characters of one of the sixteen type styles.

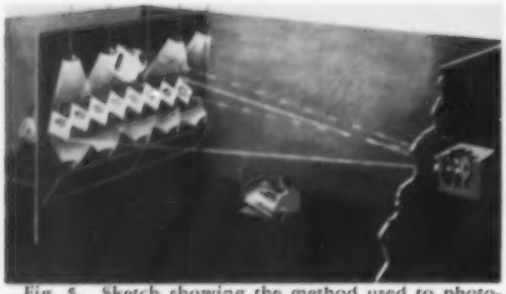

Fig. 5. Sketch showing the method used to photograph type characters on the glass matrix discs. The disc, bearing a photographic emulsion, is located in the darkroom at the right. Eight master character drawings (for eight different type faces) are on the illuminated panel at the left.

with machine-set type. The techniques of photographic double exposure may also be used to create vertical and horizontal ruled lines directly from the keyboard from a series of overlapping dashes. The precision of the machine is such that no joint, gap, or bulge is detectable in these ruled lines. It is also possible to superimpose one character entirely on top of another, such as is required when placing a letter inside a rectangle, and it is also possible to have characters abutting—one just touching the next.

These versatility features make it possible to produce far more elegant printed matter for aesthetic reasons as well as for more precise scientific text than has heretofore been economically feasible. It is anticipated that this flexibility will not only permit lower cost production than has been possible heretofore but will also encourage imaginative users of printed material to find new techniques of presentation and communication.

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A SIMPLIFIED METHOD FOR REMOVING ONE EMULSION OF A DOUBLE-COATED X-RAY FILM

R. Golden*

During a study of the properties of a double-coated x-ray film, it became necessary to remove one emulsion prior to exposure.

Two methods available involve: (1) chemical treatment to soften the gelatin and then scraping off the emulsion from the base, and (2) removal of silver halide salts by normal fixing while one side of the film is protected from the action of the solutions. A waterproof barrier is required during the treatment. Sherwood[1] has suggested various ways of taping films to protect one emulsion while removing the other. He listed a number of tapes found to give watertight joints and emphasized that leakage of solutions to the unprotected emulsion is mostly at small openings where "the tape fails to make contact between the edge of the film and the supporting surface." These small gaps are present at the film corners where overlap occurs between separate strips of tape holding the film edges to a waterproof backing.

At this laboratory, it has been found that if a liquid adhesive (3 M type EC 1022) is painted over the tape and allowed to flow a fraction of an inch onto the film along its perimeter as well as the support, it will set in ten minutes and provide a continuous watertight seal from film surface to support.

The film, when sealed to its lucite backing, may then be immersed in a tray of fixing bath and one emulsion cleared. After washing and then drying overnight in a light-tight box, the film may then be removed from the lucite by cutting with a razor blade along the inside edge of the tape. When the adhesive on the edge of the film has been trimmed off, about one-half inch of the film is lost.

This method hastens the process of removing one emulsion without affecting the other emulsion. It minimizes pressure marks of all kinds since once the film is supported by a stiff backing, such as lucite or glass, only the edges are touched. It requires no special chemical formulations, and the seal formed will remain watertight under running water for several hours.

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APPLICATIONS OF MULTIPLE-IMAGE PHOTOGRAPHY IN THE TIME-MOTION ANALYSIS OF HUMAN MOVEMENT WITH A NOTE ON "COLOR CODING"

Frank Pierce Jones and D. N. O'Connell*

ABSTRACT

A method of time-motion analysis employing multiple-flash photographic techniques has been developed during the course of applied experimental psychology studies. The human subject is dressed in dark clothing and marking patterns cut from reflective tape are attached to the portions of the body of interest for motion analysis. Stroboscopic illumination is used and both single and stereoscopic pictures in black-and-white and color are made. The study was supported by a grant from The Carnegie Corporation of New York.

Multiple-image photography has a long history, dating back to 1874 when the French astronomer, Jules Janssen, set out for Japan with a device he invented for observing the transit of Venus.[1] The ship on which he sailed was almost destroyed by a typhoon while crossing the South China Sea, but Janssen survived and reached Japan in time to make his observation of the transit on December 8. The science of photography owes much to the Providence that preserved Jules Janssen, for the device which he carried was a "photographic revolver," with which he proposed to make a complete record of the transit. The revolver consisted of a circular sensitized plate divided into 48 segments. It was rotated at the rate of one segment every seventy seconds, thus producing a series of impressions which allowed calculations of the rate of transit and time of contact to be made.[2]

Aware of the potentialities of such a technique, Janssen wrote in 1876: "The characteristic of the revolver is that it affords an automatic means of taking a series of photographs of the most variable and rapid phenomena in a sequence as rapid as may be desired, and thus opens up for investigation some of the most interesting problems in the physiology and mechanics of walking, flying, and various other animal movements."

The suggestion was soon acted upon by the French physiologist, Étienne Marey, a pioneer in the study of animal locomotion.[3] Marey modified Janssen's apparatus to produce a "photographic gun," which could take a series of fairly well-defined pictures at the rate of twelve per second[4]. The device was first used to photograph the flight of birds.[5]

Marey experimented further with this apparatus and by 1882 had developed procedures using fixed plates upon which successive exposures of a moving subject were made through a sectored disc, later known as a "Marey wheel." The disc revolved in front of the camera lens, which remained open. The subject was illuminated by direct or mirrored sunlight and moved before a black, recessed light-trap.[6]

Between 1884 and 1885 a similar procedure was employed in this country by the artist, Thomas Eakins, to make a photographic analysis of the performance of athletes at the University of Pennsylvania. His results seem remarkable even today. His method, though much simpler and of greater importance for the scientific analysis of movement, was neglected for that of his contemporary, Eadweard Muybridge, who employed a multiple-plate technique requiring many cameras.[7]

Marey in the meantime had modified his procedure to avoid the confusions of pattern that resulted from the superimposition of images produced by high exposure rates or slow movements. He dressed his subject in a suit of black velvet to which strips of white cloth or reflecting metal were attached. The outlines of the subject's body as he moved did not register on the plate, and the movement was therefore recorded as a series of "stick patterns" representing the relative positions of the head and limbs. From these a geometrical analysis of the movement could be made. Marey called the method "geometrical chronophotography."[8]

The limitations of reflected sunlight led investigators to the use of emitted light from sources attached to the subject. In 1888 Quénu and Demeny analyzed the movements of hospital patients by means of small electric lights attached to their limbs and trunk and wired to an electric battery which rested on a movable overhead platform.[9] At Leipzig, Wilhelm Braune and Otto Fischer made a classic study of human locomotion using flickering Geissler tubes (a laboratory forerunner of the neon tube). Eleven such tubes were attached to their subject, who was simultaneously photographed from four different angles as he walked past an illuminated system of coordinates. The resulting analysis (still incomplete) was published in seven sections between the years 1895–1903 and is still a standard reference in studies of human movement.[10]

As far as accuracy and thoroughness are concerned, these early studies could scarcely be excelled. Marey's photographs were taken with great care and ingenuity, and the coordinate system of Braune and Fischer was so painstakingly exact that velocities and accelerations could be calculated within an accuracy of 1 mm. The Marey wheel and its later modifications are still in use. In the recent studies of human locomotion made at the University of California, a modified Marey wheel was found to give the most accurate data of all the methods employed.[11]

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Study of Head-Neck Reflexes

Multiple-image photography has been used in this laboratory as a tool for research in the course of an investigation into the role of the head-neck reflexes in human movement. The objective was to learn how the relation between the head and trunk changes during such simple movements as walking, sitting down, or standing up. Photographic analysis of some sort seemed to be needed and it appeared desirable to record each movement on a single plate or film rather than in a series of motion pictures. The older methods described above, however, lacked the flexibility needed for this study, which was exploratory in nature at this stage.

It was thought necessary to vary the flash rate at will—a difficult procedure with a Marey wheel; and to leave the subject as free as possible in his movements—which is not the case when he is wired up with electric lights. A large amount of reliable data was needed and it had to be obtained as inexpensively as possible. After investigation, it appeared that reflecting tapes used in combination with flashes of stroboscopic light would provide the best solution for the problem.[12] The method has proved very satisfactory, and recent advances in photography have added greatly to its usefulness.

The light source used is a Strobolume-Strobotac unit manufactured by the General Radio Company. Scotchlite Reflecting Tape is used to mark the pattern to be studied. Pictures are taken both in black and white and in color on 35mm film. In order to obtain information about the third dimensional component in the movement patterns under study, it was decided to photograph subjects stereoscopically. Stereo pictures have been taken with a Stereo-Realist camera. This procedure has had the added advantage of providing two similar frames for each movement and thus decreasing the chance of failure—through accidents in processing and the like—to obtain a record of the movement. This is important since many of the effects under study are so susceptible to modification by learning that the first try with a given subject often cannot be reproduced.

Scotchlite Reflecting Tape is a glass-beaded plastic sheeting. It is commonly used to mark automobile bumpers and highway signs for night driving. Its reflective brilliance is up to 235 times that of a white painted surface. Strips and sheets may be obtained in several colors with or without adhesive backing. It is economical and can be cut into markers of any desired size and shape. It can be mounted on cardboard and taped to the skin or mounted on sticks, which can then be strapped to the subject. Tape No. 244 (Signal Silver) produced images with the greatest contrast, but No. 3270 (Silver) proved to be almost as good and is much easier to use because of its adhesive backing.

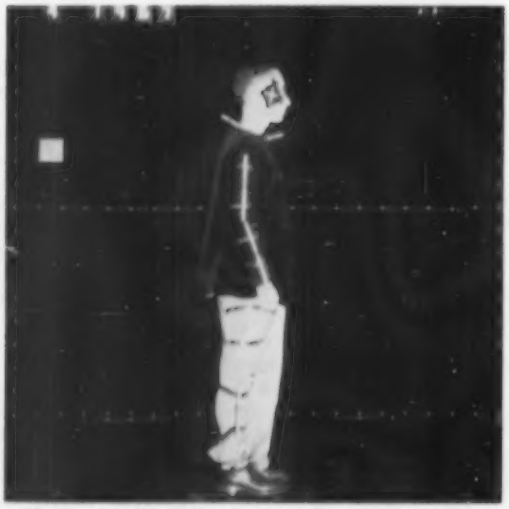

Fig. 1. Model with reflecting tapes attached to parts of the body of interest in motion analysis. The subject's shirt and the background of black velvet minimize light reflection.

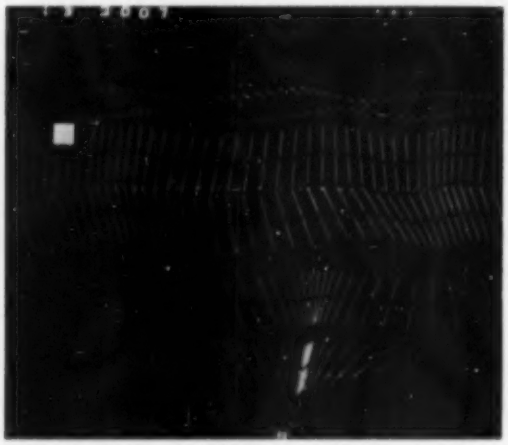

Fig. 2. Pattern made by black clothed figure walking from left to right. The light was pulsed at 1200 flashes per minute.

To mark the subject's head, a small Greek cross constructed of Scotchlite tape and backed with black cardboard is fastened to his face with adhesive strips. In a movement pattern the cross will serve to indicate not only the location of the head but its angle of rotation as well.

Two light-weight sticks, seven centimeters in length and fixed at one end to a plastic base, are attached with adhesive tape at the seventh cervical vertebra and at the sternal notch. Each is divided into two equal parts with a black line around the center. This division makes it possible by using a pair of calipers to determine the base of the marker in case it becomes obscured in the course of movement. A small piece of Scotchlite tape is attached to the subject's heel. The four stick markers for the arm and leg are fastened with black elastic straps and can be put on or removed as they are wanted. They are 24 centimeters in length and like the trunk markers are divided in half with a black line so that the pattern can be reconstructed if it is partially obscured during a movement.

To heighten contrast and reduce stray light, the experimental room has been painted a flat black; the subject is

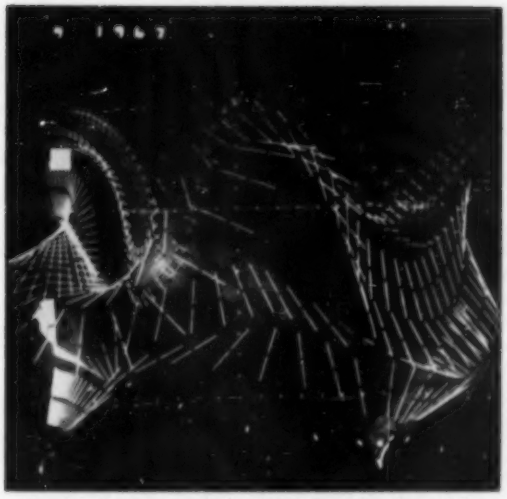

Fig. 3. Pattern made by figure jumping from left to right. Due to the complexity of the pattern, color coding is advantageous in such studies.

dressed in dark clothing; and the movements are carried out against a black velvet screen. Horizontal and vertical reference lines have been marked on the screen with white thumbtacks spaced at decimeter intervals. In addition a square decimeter of white cardboard serves as an absolute criterion for enlarging and for converting relative measurements taken from the projected negatives or from prints.

The Lighting Equipment

The Strobolume, which emits a highly directional beam, is placed behind and slightly above the camera. It is driven as a slave lamp by a General Radio Strobotac, Type 631-BL. This is a compact, stroboscopic tachometer of great accuracy and flexibility. Its range is from 60 to 14,400 signals per minute, and it is readily calibrated from line frequency. It has been found that the movements under study can best be recorded at rates of 60, 180, 300, 600, and 1200 flashes/minute. With the Strobotac the change from one rate to another can be made in an instant merely by twisting a dial.

The only practical limitations upon the flash rate are due to the Strobolume itself rather than the Strobotac. The Strobolume is a type of inert-gas lamp which provides two intensities of flash. They may be referred to as Hi-beam and Lo-beam. The Hi-beam emits flashes of 40 microseconds duration. On Hi-beam the Strobolume cannot be run continuously when the rate is higher than 60 flashes per minute, though for a few seconds at a time it has a range up to 1200. When the maximum safe operating time has been reached, an overload breaker opens automatically.

The Lo-beam which emits flashes of only 20 microseconds in duration, can be run with safety for very long periods at any rate up to 3000 fpm. Fortunately, by using the new Kodak Tri-X films and setting the lens aperture at f/3.5, black and white pictures are successfully taken with the low beam and patterns obtained that were very sharp and clear.

Use of Color Film

With the new fast Ektachrome and Anscochrome films it is possible to obtain most of these patterns in color. So far color photographs have been successful only when using the Hi-beam, and this restricts somewhat the movements that can be recorded. Quite apart from aesthetic considerations, color photography offers some practical advantages over black and white. In particular it provides a convenient solution for two problems which frequently arise in the analysis of motion. One is to keep the record of different parts such as the arm and leg distinct from each other in the course of a complex movement like jumping. A convenient way to do this is by covering each of the markers in Scotchlite tape of a different color. When the pattern is "anatomically coded" in this way the course followed by each part of the body can be determined at a glance.

The other problem is to determine which elements of a stick pattern are simultaneous when, as in walking, different parts of the body are moving at different rates. Earlier investigators solved the problem in various ways, none of them altogether satisfactory. The method developed here, and named "temporal coding," is to interpose color filters between the camera lens and the subject, using either silver or gold for the Scotchlite markers. A transparent plexiglass wheel driven by a synchronous motor revolves in front of the camera at 1 rps. It is divided into three 120° segments, one clear and the other two covered with colored filters (made by Brigham Gelatin Co., Randolph, Vt.). This provides a simple device to produce in the geometrical pattern a color sequence from which simultaneity of the portions of the pattern can readily be determined. The use of three colors has the additional advantage of allowing one to determine the sequence of a series of elements some of which have doubled back on themselves, as in the movement of bending down and picking up an object from the floor.

For studying certain movements, the advantages of temporal coding can be obtained with black and white film. If bands of Scotchlite tape in complementary

Fig. 4 Walking pattern coded in black and white to indicate simultaneity of flashes.

colors are attached to the markers, filters can then be selected which will cut out one color at a time, thus changing the photographic image and coding the pattern as before. For the pattern shown in Figure four, the Scotchlite tapes used for each marker were No. 3276 (grey blue), No. 244 (signal silver), and No. 3271 (yellow). The gelatin filters on the Plexiglass wheel were Brigham No. 36 (non-fade blue) and No. 59 (amber).

Developments in photography and electronics have carried the method of Marey a long way from the days of the photographic revolver and the photographic gun. Indeed, instrumentation is probably now available to provide conditions of experiment close to ideal. However, such an ideal solution would, very likely, involve instruments too complex for the average researcher to construct and too expensive to buy. An attempt was made, therefore, to devise an experimental setup that would employ only instrumentation that is commercially available, would be easy to maintain, and inexpensive to operate. From this point of view the setup has proved satisfactory in every respect. It has at the same time provided the flexibility and accuracy which the present investigation demands.

Acknowledgments

The possibility of using Scotchlite Reflecting Tape for this study was first brought to our attention by Dr. Howard Hembree of the Quartermaster Research and Development Command, Natick, Mass. Samples of Scotchlite in a variety of colors were supplied by the courtesy of Mr. Ben Barsanti of the Minnesota Mining and Manufacturing Co., Newton Centre, Mass. The photographic equipment was provided by The Tufts Fund for Research in Kinesthesis.

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A collection of action photographs made by Eakins was deposited after his death in the Museum of Modern Art, New York, by Charles Bregler. In a letter to the Museum, Dr. Henry Ritter, once a pupil of Eakins', said that the pictures were taken between 1884 and 1885. Excellent reproductions of six of them can be found in an article by Bregler in the *Magazine of Art*, Jan. 1943.

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John G. Heiland

Bell & Howell Company announced the appointment of John G. Heiland as Director of Research for the Chicago camera manufacturers. Mr. Malcom G. Townsley, Vice President of Engineering, also announced the appointment of Gerhard Lessman as Associate Director of Research.

Mr. Heiland, who has served as assistant director of research since 1953, will have complete responsibility for the planning and direction of the company's research program, succeeding Townsley who has served as director of research until recently.

A graduate of Wabash College, Heiland has done graduate work at the Illinois Institute of Technology. He joined Bell & Howell in 1943 as an engineer in the chemical laboratory. In 1948 he was made chief chemist and in 1951 chief of the engineering laboratories.

Heiland is a member of the American Chemical Society, the American Society for Testing Materials, the American Association for the Advancement of Science, and the Society of Motion Picture & Television Engineers. He will now be invited to join the Photographic Society of America. He lives at 1339 Center Street in Des Plaines, Illinois with his wife and daughter.

Mr. Lessman, formerly a special project engineer, came to Bell & Howell when the company purchased the DeVry Corporation in 1954. At DeVry he had been chief optical engineer since 1950. During World War II he served in the U. S. Army 3½ years in the Pacific Theatre. He retired from active duty in 1946 with the rank of Captain of Field Artillery. A graduate of the University of Chicago, he also attended the University of Cincinnati School of Engineering.

Lessman is a member of the Society of Motion Picture and Television Engineers, the Optical Society of America, Optical Society of Chicago, Delta Theta Phi law fraternity, and is a life member of the Field Museum of Natural History. He also will be invited to join the Photographic Society of America. With his wife and two daughters, M. Lessman lives on a farm near Huntley, Illinois.

A MECHANICAL DEHYDRATOR FOR FILM DRYING

Warren R. Posthumus*

SUMMARY

An air dryer is described in which the moisture is condensed onto surfaces cooled by mechanical refrigeration instead of being absorbed by means of hygroscopic media. Heat exchangers, both in the air stream and in the refrigerant cycle, increase the efficiency of the unit.

THE GENERAL PRINCIPLES of mechanical dehydration of air, through the use of refrigeration, are well known. Many units are available for domestic and light industrial use. The Pako Corporation recognized several years ago that, with certain refinements, this type of drying would be admirably suited to the drying of photographic film, including black-and-white, X-ray and color materials.

The Pako unit was tailored to produce the following advantages, over existing apparatus using heated, circulated air:

1. Faster drying at normal temperatures, or drying at lower temperatures without increasing drying time.
2. Less plant area devoted to drying, or increased production in the same drying area.
3. Improved condition of the film after drying.
4. More comfortable working conditions in surrounding photo-finishing plant area.
5. Lower operating cost.
6. Uniform drying conditions the year around.
7. Filtered, dust-free air.

The body of air used for drying the film must absorb moisture from the film. The capacity of the air to absorb this moisture depends on different factors; mainly, the moisture content, temperature, and rate of movement. The latter factor is generally well understood and it should be sufficient to note that air circulation must be provided. The other two factors, temperature and moisture content, are inter-connected in the term "Relative Humidity."

In the mechanical dehydrator, coils are cooled by a refrigeration system. Air passing over these coils is cooled, the moisture condenses out on the coils and runs down the drain. The air leaving the coils is therefore drier air, and has greater capacity to absorb more moisture.

In the Pako Dehydrator, there are additional refinements in the design, which provide efficiency. The unique feature is an air-to-air heat exchanger, in which the incoming moisture-laden air is cooled by the out-going air so a higher proportion of moisture will condense out on the refrigerated coils. At the same time, the out-going air is heated so it will have greater moisture-absorbing capacity.

Figure one illustrates the dehydrating cycle. Incoming air at about 90 F is drawn through the blower (1) and passes through the filter (2) the air-to-air heat exchanger (3) and the refrigerated coils (4) where moisture is extracted. Air temperature at this point is approximately 40 F. Air continues through the second phase of the air-to-air heat exchanger (3) absorbing heat from the incoming air, emerging at a temperature of about 60 F. At this point, a damper (5) is provided, to send the air either directly to the out-going duct or through the refrigeration condenser.

The condenser resembles an automobile radiator, through which the refrigerant gas is pumped under high pressure and temperature. If the air is passed through the condenser, it will be warmed to about 110 F, increasing its ability to absorb moisture. Various temperatures may be obtained by adjusting the damper control to allow greater or smaller portions of the air to pass through the condenser. This is the only adjustment necessary to control the drying conditions and once set, it need be changed only to compensate for seasonal changes in temperature and humidity.

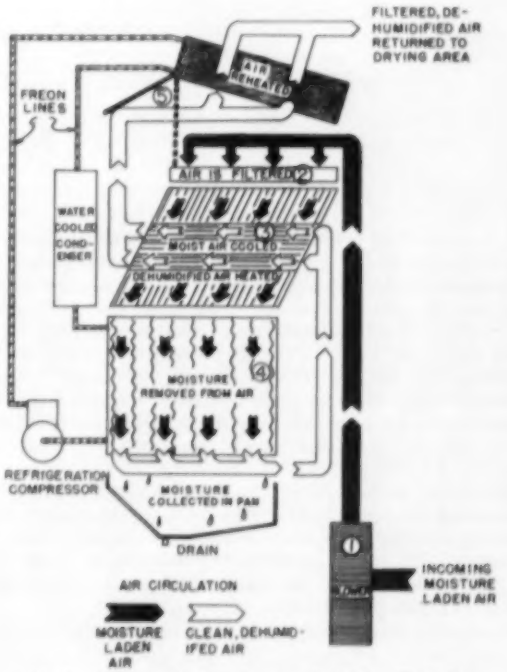

Fig. 1. Schematic drawing of the Pako Dehydrator showing the air-to-air heat exchanger in which cool, dry air takes on heat from the incoming warm, moist air.

* Pako Corporation, Minneapolis, Minnesota. Presented at the PSA National Convention in Boston, Massachusetts, 5 October, 1955. Received 2 December, 1955.

The air-to-air heat exchanger consists of a multiple sandwich of aluminum sheets, formed and joined in such a manner that the incoming air passes vertically through the spaces between alternate pairs of sheets, and the outgoing air passes horizontally through the intervening spaces. This provides a large heat-exchanging area in a compact unit, and results in cooling of the incoming air so a higher proportion of moisture will condense out on the refrigerated coils. At the same time, the out-going air is heated so it will have greater moisture-absorbing capacity.

The refrigeration system is of conventional design, incorporating a compressor of 2-ton rating, standard evaporator coils and pressure-limiting thermostatic expansion valve controlled by temperature of the suction line. Refrigerant is Freon 12. Two condensers are employed, one air-cooled and one water-cooled, in series. When the out-going air is directed by the damper through the air-cooled condenser, the water-cooled condenser "loafs," but when the air by-passes the air-cooled condenser, the water-cooled condenser carries the load. Operation of the water-cooled condenser is automatically controlled by the compressor head pressure.

The general purpose model of the Pako Dehydrator is 36 inches long, 26 inches wide and 75 inches high. It has a drying capacity of 600 to 700 rolls of amateur roll film per hour, with drying time of 20 minutes.

The blower and refrigeration compressor are both driven by a single 2 hp motor, and total operating load is 1.9 kilowatts.

As an example of performance, this unit has produced out-going air at 105 F and 19% relative humidity with incoming air at 75 F and 60% relative humidity.

Other models have also been built, including a self-contained dehydrating Drycab for photo-finishing and professional-commercial photographers, and a tunnel-type continuous dryer for X-ray film.

EXPOSURE WITH PORTABLE ELECTRONIC FLASH UNITS

John Debes and Ronald Karley*

SUMMARY

This article discusses how to properly expose films by the light of the small portable type of electronic flash unit rated at anywhere from 50 to 200 wattseconds.

To *anyone* who takes electronic flash pictures, the flash guide number holds the answer to the proper exposure of whatever film he is using. At present, the usual way to indicate the power of an electronic flash unit is to give the number of wattseconds of electrical energy that is fed into the flash tube. But, in photography, the basic question is usually, "How much light is there." And, because wattseconds are units of power, a specification in wattseconds does not tell how much *light* a unit throws on a subject. In other words, wattseconds can*not* be converted directly into guide numbers.

Recently, it has been recognized that by properly measuring the amount of light that actually reached the subject, making these measurements in "beam" or more correctly "effective" candlepower-seconds, a figure can be obtained that *can* be converted directly into flash guide numbers that work.

However, it is important to keep in mind that "watt-seconds" is not entirely meaningless as an indication of how much light a unit puts out.

Exposure Guide Numbers

These can be calculated directly from "beam-candlepower-seconds" or, more accurately, the "effective candlepower-second" output, if this figure has been accurately furnished. This is described later.

The best guide number for your use is one which you establish photographically as follows: At 10 feet from typical subject matter, expose color film at f/2.8, 3.5, 4, 4.7, 5.6, 6.5, and 8. After processing, project the slides correctly, choose the best *f*-number, and multiply it by 10. This gives the best guide number for your flash unit, camera and subject matter.

Shutter time does not affect the guide number for electronic flash. The test is made with reversal color film because its exposure is critical. From the value so obtained, guide numbers can be found for black-and-white films. However, because of the wide latitude of black-and-white film, the reverse is not true.

* Eastman Kodak Company, Rochester 4, New York. Adapted from Kodak Photo Notes Number 2, 1955. Received 12 September 1955.

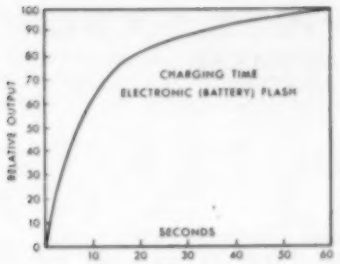

Fig. 1

Fig. 1 Typical curve showing recharging time for portable electronic flash unit using battery power source.

Guide numbers for other films can be found from:

$$\frac{\text{G.N. film A}}{\text{G.N. film B}} = \sqrt{\frac{\text{Daylight Exp. index film A}}{\text{Daylight Exp. index film B}}}$$

Duration of Flash

The average total duration of flash is about 1/250 second, but the photographically useful part of the flash (strongest $^2/_3$) averages 1/1000 second. This is much longer than the flash from the larger studio outfits. At portable unit exposure times (1/250 to 1/2000), there is no film-speed change or reciprocity effect great enough to be detectable even in carefully made pictures, for either black-and-white or color films.

Timing of Flash

For practical purposes, the flash follows instantaneously the closing of shutter contacts. Therefore, the usual synchronization (delayed) is not used (unless the unit has a built-in "F" or "M" delay). The "X" setting is generally used so that contact is made when the shutter blades are fully open. You can check synchronization easily. When the camera is empty, work the shutter while looking through the camera from the back. If the shutter blades appear fully open as flash occurs, synchronization is correct.

Filters Required for Color Film

Many photographers find that the use of daylight-type color film without a light-balancing filter yields transparencies of quite good color balance. In some cases, however, more accurate color balance may result when a light balancing filter is used, especially with new lamps. A lens opening about one third larger is required when this filter is used. As lamps age, they may change somewhat in light quality, and no filter may then be needed.

Most of these units produce light of practically identical color. Therefore, the same filters can be used.

Charging Time

As can be seen from Figure one, it usually takes a minute to recharge the unit to fullest capacity with batteries, but after 10 seconds a typical unit will produce about 70 percent of its maximum light output. An a-c power unit is usually quicker in recharging.

Table I

GUIDE NUMBERS FOR FILMS WITH PORTABLE ELECTRONIC FLASH UNITS

(Daylight) Exposure Index	Effective Candlepower Seconds Output of Unit									
	350	500	700	1000	1400	2000	2800	4000	5600	8000
50	32	40	45	55	65	80	100	110	130	160
200	65	80	95	110	130	160	200	220	260	320
25	24	28	32	40	45	55	70	80	95	110
10	15	18	20	26	30	35	45	50	60	70
32	26	32	35	45	55	65	80	90	110	130

Other Causes of Light Loss

As batteries lose power due to use and age, the necessary charging time increases. When the battery is used to the extent that its voltage drops below the required value, light output decreases. Another factor which can weaken the batteries and thus result in loss of light output is the tendency of electrolytic condensers to "deform" after a month or so of nonuse. It takes an extra long time to "reform" and bring the condensers back up to full charge. This can be quite a drain on the batteries. ("Re-forming" consists in electrically building up the insulating layer which separates the metal foil and the electrolyte.) If a unit can be used on regular house current, it's a good idea to recharge from the power line after a layover of a month or so.

Damage to Shutter Contacts

Although most of the electronic flash units on the market today are safe to use, there are a few units which send either the full charge or a large proportion of the current through the shutter contacts thus causing arcing across the contacts. This results in such damage as pitting and even welding the parts together.

Effective Candle-power-Second Output

You can compute your own guide numbers if you know the effective candle-power-second (ECPS) output of a unit. You simply insert that figure and the daylight exposure index of the film into the formula for determining guide numbers.

$$\text{Guide No.} = \sqrt{.063 \times \text{ECPS} \times Z},$$

where Z is the index of the film. This formula is derived from the American Standard formula for calculating Exposure Guide Numbers for Photographic Lamps. Unit manufacturers may either publish the ECPS output of their unit or supply it on request. When properly measured, the ECPS figures should consider not only the light along the axis of the lamp, but also that spread over the useful field as well. Measurements at the various beam angles can be combined into a single figure for ECPS by following the weighting method outlined in the American Standard for guide-number determination.

SIZE D BATTERIES AS A POWER SOURCE FOR ELECTRONIC FLASH

George W. Ward*

MARKET RESEARCH has strongly indicated a definite sales potential for inexpensive portable electronic flash equipment. A low cost, readily available battery power supply was shown to be a prime requirement in all market surveys made by this organization. The size D photo-flash battery satisfactorily answers this basic requirement, and units with this type of power supply are currently enjoying considerable sales success.

A properly designed "D" battery portable unit is serviceable equipment for the average amateur photographer—*provided that he understands its performance limitations*. Tests made by the Heiland Division indicate that such a unit is capable of delivering several hundred flashes per year at an average cost of less than 1 cent per flash.

Factors Affecting Battery Performance

Performance characteristics of a properly designed 40 watt second "D" battery unit are conditioned by several factors. Since the "D" photoflash battery has good recovery ability, operational use has a decided effect upon overall battery service. The amount of energy drawn from the batteries during the intervals between flashes also has a direct effect upon service life of the batteries. An idle current drain of 600 ma at 450 v is a design limitation common in varying degrees to all voltage multiplier circuits. Therefore, maximum battery service is obtained by turning the unit off between flashes.

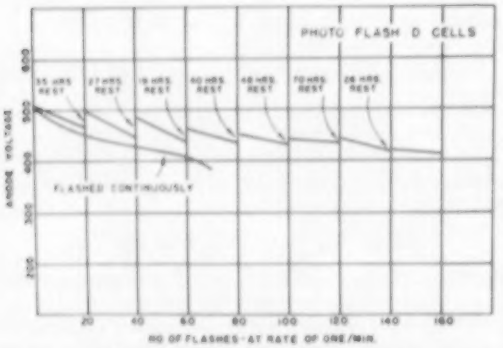

Fig. 1. Effect of continuous flashing on battery life compared with intermittent use, showing the recovery ability of the "D" photoflash batteries.

Figure one illustrates continuous and intermittent performance of four "D" photoflash batteries, charging one 400 microfarad, high purity, 450 volt formed capacitor. Both sets of batteries used were of the same manufacture.

Capacitor condition (formed or deformed) is an important factor that affects the operating characteristics of any portable electronic flash unit. The magnitude of the problem created by deformed capacitors is relative to the type of power supply used. An average of tests

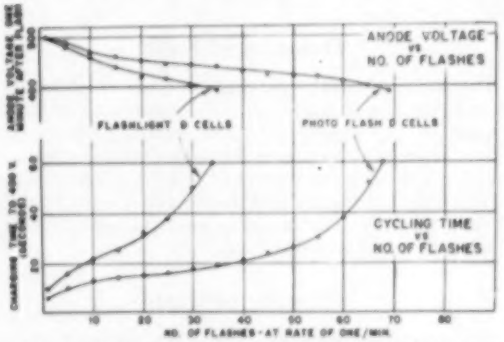
ANODE VOLTAGE vs NO. OF FLASHES
FLASHLIGHT D CELLS
PHOTO FLASH D CELLS
CYCLING TIME vs NO. OF FLASHES
NO. OF FLASHES - AT RATE OF ONE/MIN.

Fig. 2. Comparative performance averaged for four "D" photoflash batteries and four "D" flashlight batteries.

indicates that a high purity 400 microfarad, 450 volt capacitor will deform sufficiently in 60 days of non use to reduce the service life of the "D" battery by 15-20%. Maximum battery service can be maintained by any of the following methods:

1. Form the capacitor with a suitable ac operated device before using the battery power supply.
2. Form the capacitor with an old set of batteries before installing a new set.
3. Keep the capacitor formed by operating the unit at least twice a month.

Photoflash vs. Flashlight Batteries

The flashlight battery can be used as a substitute for the photoflash battery, if necessary. This battery is more readily available and less costly than the photoflash battery. As can be seen by Figure two, it does not equal the operating performance of the photoflash battery. However, since the shelf life of the flashlight battery exceeds that of the photoflash battery, it may be a suitable choice for occasional operation providing the photographer is willing to tolerate certain operational characteristics. Figure two illustrates comparative performance of four "D" photoflash batteries and four "D" flashlight batteries.

* Heiland, a Division of Minneapolis-Honeywell 5200 East Evans Avenue, Denver, 22, Colorado. Presented at the PSA National Convention in Boston, Massachusetts, 7 October 1955. Received 15 September 1955.

Comparative Power Systems

Since the introduction of portable electronic flash to the photographic market, four power systems have been used. These systems can be classified as follows.

1. Storage battery (wet) voltage multiplier circuit
2. Dry battery—voltage doubler or tripler circuit
3. Dry battery—voltage multiplier circuit
4. Dry battery—B. C. circuit.

Each system has its advantages as well as its disadvantages; therefore, it is important for the photographer to analyze his requirements before selecting his equipment. As compared to other powering systems, "D" cell operation has the shortcomings of longer recycling time, with greater initial cost and weight resulting from the need for a vibrator and transformer. However, these disadvantages are offset by the low cost and ready availability of battery replacements. Because most hobbyists and "occasional" photographers would rather spend a small amount of money at frequent intervals than invest in a more expensive high voltage battery supply, the future of "D" battery power packs seems well assured.

THE EXAMINATION OF SOME MICROSCOPE SLIDES BY USE OF SCHLIEREN AND SHADOWGRAPH TECHNIQUES

D. S. Schwartz*, F. Thornton, L. M. Somers, and W. C. Lenz†

SUMMARY

The authors present the results of a preliminary study made to determine the feasibility and usefulness of examining microscope slide specimens by schlieren and shadowgraph techniques. Photographs, taken with and without diffuse light as in a microscope, as well as schlieren and shadowgraph photographs, are presented for comparison purposes. Results indicate that it might be profitable to continue this study by projecting the schlieren image of the specimen slide through a microscope.

A MICROSCOPE is designed to permit observation of structure which is impossible to observe with the naked eye. A schlieren image projected through a microscope should give density gradients and structure, if diffraction effects are not too large. It is probable that a knowledge of the density gradients in a thin section of normal or diseased tissue would be of great value to the biologist or physician. Schlieren or shadowgraph techniques might also prove valuable in reconstructing three-dimensional models of tissue as to its densities. By mounting thin, successively cut, tissues and taking schlieren or shadowgraph photographs of them, one might reconstruct the densities and structure of the original subject. It is for these reasons that preliminary experimentation was initiated.

The apparatus used to obtain the schlieren photographs and shadowgraph records is shown in Figure one. For general schlieren and shadowgraph techniques, see reference 1. Because no parabolic mirrors were available, a simple parallel light system was constructed using two achromatic lenses of 51mm diameter and 180 mm focal length. They were mounted in metal hose clamps for support. These lens mounts were attached to an optical bench constructed of 1½ inch angle iron 42 inches long. A point source of light, a Western Union Zirconium Lamp, Type C-100, was mounted in the same manner as the lenses. A variable rectangular aperature, with four adjustable jaws, was used as the knife edge. Thus, horizontal or vertical knife edges could be obtained as desired. The other three edges were adjusted to stop stray light from entering the Speed Graphic Camera. Photographs were obtained with a lens setting of f/4.5 on Kodak Contrast Process Ortho

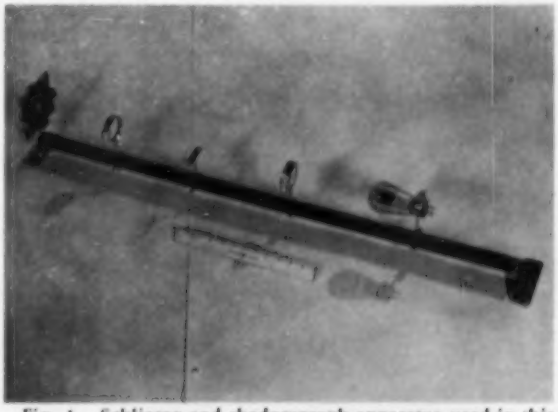

Fig. 1. Schlieren and shadowgraph apparatus used in this study was constructed very simply and inexpensively. Hose clamps served as lens holders. A zirconium arc provided the light source.

* Glencoe Corporation, 212 Durham Ave., Metuchen, N. J., and † Cornell Aeronautical Laboratory, Inc., Buffalo, New York. Received 19 September, 1955

film at times of $^1/_{50}$ or $^1/_{100}$ of a second. Shadowgraph were obtained with this system by removing the knife edge from the focal point of the second lens.

An achromatic lens will yield images free from prominent color halos, though faint green and pink colors are noticed in the image when the focus is shifted slightly. This slight residual color is not objectionable for ordinary work, but is highly undesirable in schlieren techniques. These colors were inherent in the system used.

To simulate conditions from a microscope, a photographic enlarger was used with and without a diffusing screen. Photographs by both methods are presented here so that a comparison can be made with the photographs taken by the schlieren and shadowgraph methods. The microscope slide was placed in the negative holder of the enlarger, its image being projected directly upon printing paper. With this procedure, no photographic negative was obtained, thus eliminating a step in the process of reproduction whereby details could be lost.

A magnification of about unity was obtained on all schlieren and shadowgraph negatives. These negatives were printed on photographic paper to the approximate size of the direct enlarger prints. It was felt that the schlieren and shadowgraph photographs would not be favored by following these procedures. Even with these apparent drawbacks imposed upon the schlieren and shadowgraph records, they seem to show superior detail in certain cases.

The photographs are identified in the following manner: An A after the figure number will denote a photograph taken without a diffusing screen on the enlarger, B will signify the use of a diffusing screen, C will depict

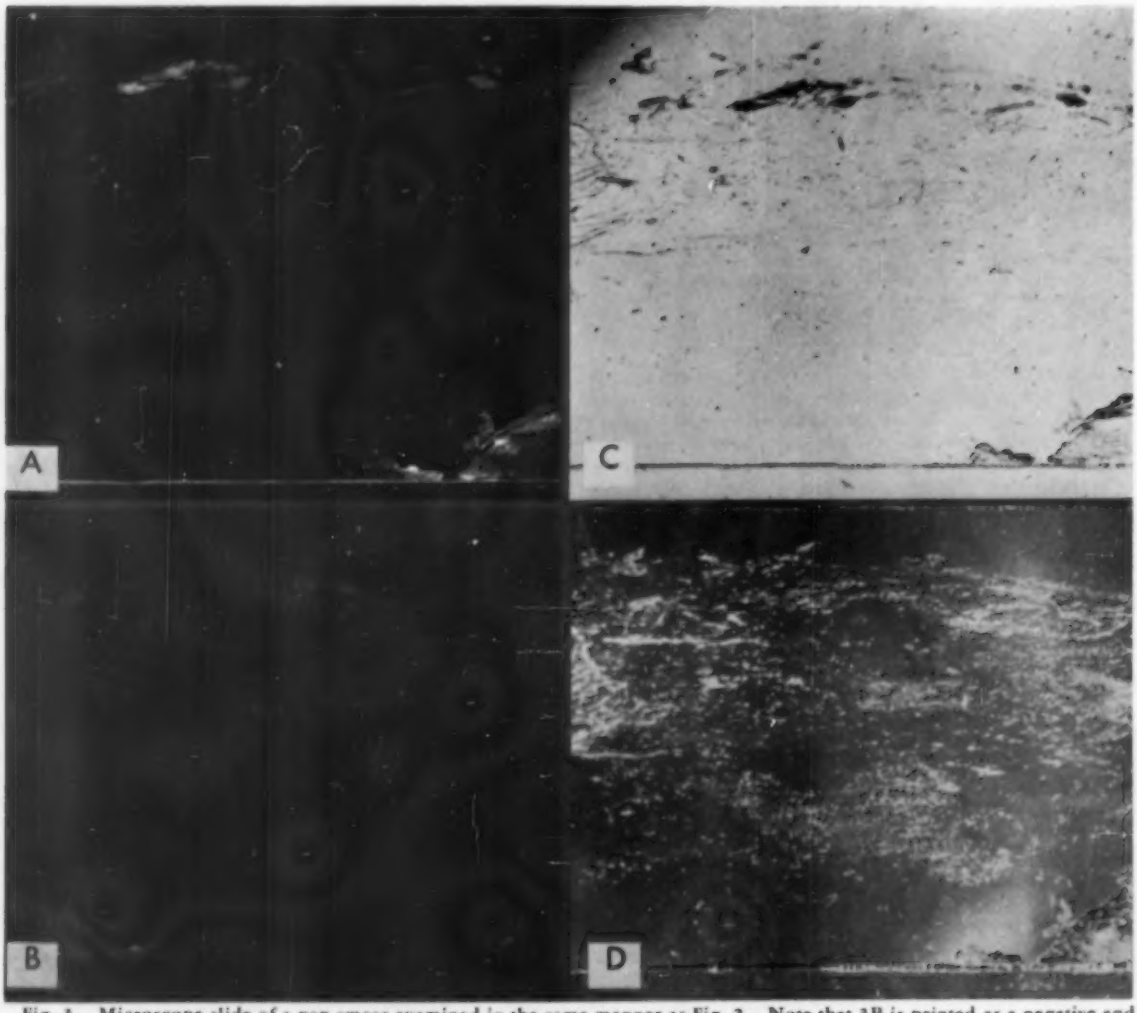

Fig. 3. Microscope slide of a pap smear examined in the same manner as Fig. 2. Note that 3B is printed as a negative and 3A, 3C, and 3D are positive prints. This method for viewing microscope slides appears promising in certain respects.

the shadowgraph technique, and D will be given to photographs obtained by the schlieren method using a vertical knife edge. Figure two will identify a microscope slide of a smear, Figure three a slide of a pap smear, and Figure four will identify a slide of stained spleen. Care should be taken in comparing photographs 2A, 3B, and 4A in their sets as they are printed as negatives while the others are printed as positives.

Being neither physicians nor biologists, the authors do not attempt to interpret the results with respect to utility. Figure 2A obviously shows more detail than any in its set. This might be predicted because the microscope slide of the tissue is very dense and contains much structure. This fine structure might be expected to produce diffraction in Figure 2D, which would cause a blurring of the photograph. Attention is called to Figure 2B which has much less detail than either of Figures 2C or 2D. It should also be remembered that the magnifications and number of steps in the photographic process are more favorable to the enlarger prints. Better results in Figure 2D would have been obtained if the slide material had been thinner.

It is evident that the shadowgraphs and schlieren photographs, Figures 3C and 3D, of the pap smear show details which do not appear on Figures 3A and 3B. This is an optically thin slide which is most favorable to the schlieren technique. Figure 4C seems to show the most detail in its set.

The sketchy discussion above was deliberate since the interested reader will study each set of photographs and form his own opinions. To the authors it seemed that this method of examining tissues on microscope slides appears promising.

From these results one cannot decide if the shadowgraph or schlieren photographs show more. It is to be expected that better schlieren photographs could be obtained with schlieren systems of higher quality. Photographic negatives, obtained by schlieren methods, can be numerically evaluated, as to densities, while those obtained by shadowgraph technique are difficult to evaluate.

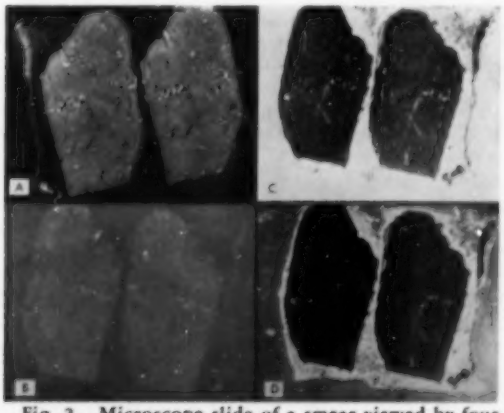

Fig. 2. Microscope slide of a smear viewed by four photographic techniques; A. With the microscope slide projected by means of a photographic enlarger with undiffused illumination, B. With diffused illumination, C. Shadowgraph method, D. Schlieren method.

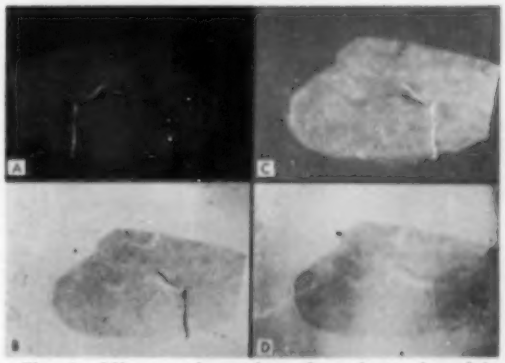

Fig. 4. Microscopic section of a spleen, viewed in the same four manners. In this case 4A is printed as a negative. The pictures are shown as indications of the results to be expected. Much better quality results would be expected from more elaborate optical equipment of the same general type.

Colored schlieren pictures can be obtained by using a source of white light and a prism placed in front of it to produce a spectrum in the focal plane of the second lens or mirror. A slit parallel to the bands of the spectrum is used instead of the knife edge. If the light is deflected by a gradient of refractive index in the disturbance, the corresponding spectrum moves across the slit and the image of the disturbance changes color. This method is especially valuable for visual observations, as the eye is more sensitive to changes of hue than to changes of illumination.

Many other variables should be investigated. Two of these are mentioned as follows; the effects of optical densities and thicknesses of the samples on the microscope slides, and diffraction effects due to structure. Various kinds of tissue should also be observed with the schlieren system as this method would probably be more effective in some cases than in others.

The results of this preliminary study indicate it might prove very rewarding to project the schlieren image through a microscope. It is hoped that this method will prove of some value in the biological and medical fields.

Acknowledgments

The authors wish to express their appreciation to Dr. Stoll of Roswell Memorial Hospital for supplying the microscope slides and to the Reverend John Frisch and Miss Katherine Treanor of Canisius College for the loan of various pieces of equipment. Mr. Charles Treanor of the Aerodynamics Department was extremely helpful with his criticisms and technical advice. Mr. Edward Sulley of the Photographic Laboratory was helpful with his advice on the fine points of photography.

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DR. MEES RETIRES FROM KODAK COMPANY

Dr. Mees

The internationally known scientist, Dr. C. E. Kenneth Mees, retired on Nov. 15, 1955 as Vice-President in Charge of Research for the Eastman Kodak Company. Dr. Mees continues as a member of the Board of Directors. He has taken up permanent residence at his home in Honolulu, Hawaii.

The son of a Wesleyan minister, Dr. Mees was born at Wellingborough, England, on May 26, 1882. He received a classical education but his interest in general science and photography dates from his early boyhood. While at St. Dunstan's College he had met S. E. Sheppard with whom he often discussed what happened to a plate when it was exposed in a camera and developed to a negative. Their search of published information in the library at University College, London, however, revealed very little until Sheppard came upon the classical paper by Hurter and Driffield, which had been published in 1890. Using apparatus built by themselves, Mees and Sheppard repeated and extended the work of Hurter and Driffield. The results were submitted to the examiners as theses for the B.Sc. degree by research, the first and last time such a degree was granted by London University.

Following the granting of the degrees to them in 1903, the two students continued their work on the theory of the photographic process and in 1906 published their researches jointly as a book, "Investigations on the Theory of the Photographic Process." On the basis of this work, each was granted the D.Sc. degree.

When he had completed this work, Dr. Mees considered remaining at college as a teacher, but Sir William Ramsay persuaded him to enter industry where, Ramsay said, research workers were needed. Dr. Mees joined the small photographic firm of Wratten and Wainwright, Ltd. at Croydon, England in 1906 as a partner and joint managing director, where he remained for 6 years.

In 1912, at Mr. Eastman's invitation, Dr. Mees joined the Eastman Kodak Company and went to Rochester, New York to organize and direct a research laboratory. Dr. Mees pioneered as a director of an industrial research laboratory. The Kodak Research Laboratory was one of the first in industry in the United States to conduct a program of fundamental research, which up to that time had been restricted almost exclusively to universities.

During the forty-four years in which Dr. Mees was concerned with operations at Kodak Park, he realized two of his life ambitions: (1) the development of a science of photography, and (2) the application of science to industry. The latter program has resulted in the introduction of new photographic materials for the amateur and the professional, the industrial worker and the scientist. Dr. Mees was named a director of the Kodak Company in 1923 and was elected Vice-President in Charge of Research and Development in 1934.

In the last half century, Dr. Mees has been prolific also as a writer, lecturer, and world traveler. He published nine books and some 160 scientific articles and pamphlets. The greatest of these is his book "The Theory of the Photographic Process" published in 1942 and revised in 1954. His book "the Path of Science," published in 1946, is an account of science for historians and of world history for scientists. With J. A. Leermakers, an assistant director of the Laboratory, he is co-author of the book "The Organization of Industrial Scientific Research," a complete revision of his book published in 1920 which was the first of its kind.

Dr. Mees' work has been recognized by awards and honors presented to him from societies and organizations in many countries of the world. He is a Fellow of the Royal Society of London, a member of the American Philosophical Society, and a member of the National Academy of Sciences as well as the recipient of awards from many photographic societies. Dr. Mees was elected Honorary Fellow of the Photographic Society of America and he is a Cornerstone Member of the Society.

ANALYTICAL-CAMERA SERVICES AVAILABLE

High-speed photography facilities are being made available to researchers through a special department set up by Beckman & Whitley, Inc., camera manufacturers of San Carlos, California. Originally conceived for the working out of application problems, this new facility is being broadened in scope to permit the accommodation of custom projects where the amount of work does not appear to warrant the acquisition of camera facilities, or for the evaluation of a projected installation.

A full-scale staff of technicians, scientists, and specialized consultants is available so specific experiments can be set up either by the customer or by this group.

Services available include photographic studies of detonation, electrical discharge, exploded-wire experiments, shock-wave phenomena, and photo-elastic manifestations of dynamic stresses in structures. These can be made at framing rates as high as 1,200,000 per second and under conditions of either reflected light or schlieren illumination. The particular fields of interest covered include ballistics, vibration analysis, flame study, fluid flow, acoustics, and high-velocity mechanical motions.

BOOKS RECEIVED

LA TECHNIQUE DES REPRODUCTIONS PHOTOMÉCHANIQUES. L. P. Clerc. Published by Établissements Bouzard-Calmels, 10 Boulevard de la Bastille, Paris (XII°), 1955. 729 pages, illustrated. Price unknown.

Shortly after completing the fourth edition of the Ilford Manual of Process Work, Mr. L. P. Clerc published in 1947 La Technique des Reproductions Photomécha niques, the second edition of which has now appeared (as has the 6th edition of his Technique Photographique) in the indefatigable author's 80th year.

The book was originally based on courses held between 1922 and 1945 at Collége Technique Estienne. Essentially therefore it is a textbook for the student but also useful for technicians or anyone else looking for information on the basic aspects of the discussed operations. The author's activity as editor of Science et Industries Photographiques, for which he is probably most widely known, insures that the treatise is up to date. On its 729 pages the book covers a large field. Following an introduction (historical, nature of light and color, photometric units) the material is divided into 11 sections of varying length: the optical image (1), the negative (2), photographic operations (3), printing processes (4), etching (5), photogravure (6), similagravure (7), photolithography (8), phototypy and gelatin relief processes (9), heliogravure (10), and multicolor photomechanical processes (11; about 100 pages). The alphabetical subject index occupies 13 pages.

With the dearth of recent books on the discussed subject in any language, anyone interested in photomechanical processes will be glad to have this work to consult, even if he may occasionally have to struggle with technical terms not to be found in his French dictionary. G.A.W.

MATHEW BRADY, HISTORIAN WITH A CAMERA. J. D. Moran. Crown Publishers, Inc., New York. 1955. 244 pages. $7.50.

The author has pieced together from various sources the remarkable story of the New York farm boy who, in spite of poor eyesight, became one of the earliest and finest photographers, using at first Daguerrotype and later collodion plates. The story is drawn against the historical background of his time, which is fitting, for Brady did not only cover the Civil War, which spread his fame and cost him his fortune, but also attracted the celebrities of his day to his studio. The second, larger, part of the 8½ x 12 inch book is made up of 453 photographs, mainly from Brady's and his assistants' large output, the greater part of which is now housed in the Library of Congress.

It is difficult to imagine how anyone would not be fascinated while leafing through the pages, be it with admiration for the pictorial results obtained with primitive photographic materials, interest in the appearance of the cultural, military, political, and social leaders of the last century, or curiosity about the early American scene and history. G.A.W.

RESEARCH FILMS IN BIOLOGY, ANTHROPOLOGY, PSYCHOLOGY, AND MEDICINE. Anthony R. Michaelis. Academic Press Inc., New York, N. Y. 1955. 490 pages, illustrated. Price $10.00.

This book presents a comprehensive study of applications of the motion picture to fields other than entertainment. Although designed for producers and users of research films in the experimental sciences, the work describes the methods successfully employed in the art of technical cinematography and provides much of interest to the worker in other fields of photography.

The author took his doctorate in Chemistry at London University and, since the end of World War II, has devoted himself to cinematography as an adjunct to research work. He has made research films on numerous subjects and has worked at the University of Sydney, Australia before returning to London to continue his professional career as a consultant in scientific cinematography.

The book is divided into three parts, the first of which deals with the biological sciences and presents detailed information on mechanical and optical techniques used in cinemicrophotography, time-lapse mechanisms, and experimental studies of plants, animals and humans.

Part Two considers applications of motion pictures to the sciences involving humans; anthropology, psychology, psychiatry, and archaeology. The third part of the book is devoted to the medical sciences and their uses of the motion picture in diagnosis, surgery, radiography, physiology, internal medicine, neurology, and pathology. An extensive author and reference index and a subject index add greatly to the usefulness of Dr. Michaelis' book.

LEICA MANUAL AND DATA BOOK, Thirteenth Edition entirely revised and reset. Edited and published by Willard D. Morgan and Henry M. Lester, New York, 1955. 456 page, illustrated in black-white and color. $6.00.

Twenty printings in twenty years, since the first edition of this classic handbook appeared in August 1935, testifies to its wide acceptance. The present edition has been revised to take the newest (M3) model Leica camera into account and to acknowledge the use of the miniature camera for color photography. The timeliness of the data is attested by the fact that the new high speed Anscochrome and Ektachrome 35mm films are included in the Handbook and fully described. Practical applications of the Leica camera have been extended in scope and pictorial aspects, while not neglected, are made subordinate.

The technical data have been handled with great competence and presented in a sensible manner as well as with great clarity. The novice will be informed without confusion and pain. The expert will find the data he seeks without tedium and delay.

A particularly useful addition to this thirteenth edition is the section on picture taking with flash bulbs, often an uncertain process in the case of a camera with focal plane shutter. A complete set of guide numbers is given which have been worked out in cooperation with flash lamp manufacturers and proved by thousands of actual exposures made with all available types of lamps. W.P.B.

A new data book containing facts on exposure indexes, guide numbers, photographic lamps, reflectors, lighting techniques, and picture-taking information has been published by the General Electric Company through their Photo*graphic* Lamp Department.

The booklet is available from photographic stores at 10 cents a copy. Titled "G-E Photolamp and Lighting Data Booklet" it consists of 40 pages 3½x4½ inches in size which makes it handy to carry in a shirt pocket.